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Hdmi decal and fine line flexible interconnect forming methods

Abstract:

Abstract of EP 0801423

(A2) Translate this text Methods of forming high density multilayer interconnect (HDMI) structures (10) on a relatively large carrier (11) and subsequently releasing and removing one or more of the HDMI interconnect structures (10) to provide useable flexible interconnects or decals are disclosed. In general, a carrier (11) is provided and a release layer (12) is formed on the carrier (11). Flexible high density multilayer interconnect structures (10) are fabricated on the release layer (12). The release layer (12) is processed to release and remove one or more flexible HDMI structures (10) from the carrier (11). The carrier (11) may be an ultraviolet transparent substrate, such as quartz, for example, and the release layer (12) may be a polyimide layer.; The HDMI structures (10) are released by irradiating the release layer (12) through the transparent carrier (11) using ultraviolet radiation from an ultraviolet radiation source (18). Alternatively, a silicon carrier (11) may be used that has a metal or silicon dioxide release layer (12) formed thereon. The HDMI structures (10) are released from the metal or silicon dioxide release layer (12) by using wet etching procedures.

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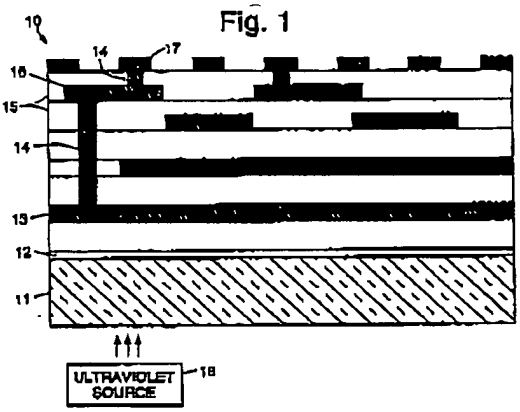
(54) Hdmi decal and fine line flexible interconnect forming methods

(57) Methods of forming high density multilayer interconnect (HDMI) structures (10) on a relatively large carrier (11) and subsequently releasing and removing one or more of the HDMI interconnect structures (10) to provide useable flexible interconnects or decals are disclosed. In general, a carrier (11) is provided and a release layer (12) is formed on the carrier (11). Flexible high density multilayer interconnect structures (10) are fabricated on the release layer (12). The release layer (12) is processed to release and remove one or more flexible HDMI structures (10) from the carrier (11). The carrier (11) may be an ultraviolet transparent substrate, such as quartz, for example, and the release layer (12) may be a polyimide layer. The HDMI structures (10) are released by irradiating the release layer (12) through the transparent carrier (11) using ultraviolet radiation from an ultraviolet radiation source (18). Alternatively, a silicon carrier (11) may be used that has a metal or silicon dioxide release layer (12) formed thereon. The HDMI structures (10) are released from the metal or silicon dioxide release layer (12) by using wet etching procedures.

Fig. 1



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Description

BACKGROUND

The present invention relates generally to processing methods for forming high density multichip interconnect (HDMI) structures, and more particularly, to methods of forming flexible HDMI decals comprising flexible fine line interconnect structures.

Conventional flexible interconnect manufacturing techniques are limited in terms of the available materials that may be used and the line densities that may be achieved. The latest generation integrated circuits (IC), liquid crystal displays, three dimensional electronic structures, and infrared detectors impose a greater demand for higher density interconnects with improved thermal, environmental stability and lower cost.

Presently available state of the art flexible interconnect cables are fabricated in a non-integrated circuit fabrication environment that limits their fine line density. Generally, conventional flexible connection cables are formed by applying an adhesive layer between each of the multiple layers to hold them together. This limits the operating temperature and the thermal stability of the fabricated flexible interconnect cables. Interconnect metallization in the conventional flexible interconnection cables is typically formed using copper which is not a radiation-hardened material and is not optimal for use in power and radiation-hardened space and military applications.

Accordingly, it is an objective of the present invention to provide for methods of forming flexible HDMI decals comprising flexible fine line HDMI interconnect structures.

SUMMARY OF THE INVENTION

To meet the above and other objectives, the present invention provides for methods of forming a plurality of high density multilayer interconnect (HDMI) structures on a relatively large carrier or substrate and subsequently releasing one or more of the HDMI interconnect structures to provide useable flexible interconnects or decals. In general, a carrier is provided and a release layer is formed on the carrier. A flexible high density multilayer interconnect (HDMI) structure is then fabricated on the release layer. Finally, the release layer is processed to release and remove one or more flexible HDMI structures from the carrier.

In one embodiment of the present method, the carrier comprises a rigid ultraviolet transparent substrate or wafer. The release layer is formed on the ultraviolet transparent carrier that is subsequently processed to release the HDMI interconnect structures from the carrier. The release layer may comprise a polyimide layer when the ultraviolet transparent carrier is used.

The plurality of HDMI structures are formed on the carrier and release layer using well-known MCM-D processing techniques. Each of the HDMI structures comprise layers of polyimide having aluminum or copper fine line interconnects and vias formed therethrough that provide signal paths from bond pads disposed at a surface of the HDMI structure to other bond pads that are used to connect to electronic components.

Once the plurality of HDMI structures are formed on the release layer, a short wavelength ultraviolet radiation source, which may be programmable and controllable, is used to release individual ones of the HDMI structures. Alternatively, a flood beam ultraviolet radiation source may be used to release many or all of the HDMI structures from the ultraviolet transparent carrier. The ultraviolet source is caused to radiate ultraviolet radiation through the transparent carrier and onto the release layer disposed between the fabricated HDMI structures and the carrier. For example, a controllable ultraviolet laser may be used to selectively irradiate each of the HDMI structures, in conjunction with a programmable pick and place machine, for example, to release and remove it from the release layer and carrier.

To achieve the removal of HDMI structures, ultraviolet radiation (photons) from the ultraviolet source interacts with the polyimide layer adjacent to the carrier and ruptures or otherwise breaks the adhesive bond therebetween. This permits the HDMI structures to be lifted off of the carrier using the programmable pick and place machine or other tool. Multiple HDMI structures may be released from the carrier using the wide area ultraviolet source in a similar manner.

The present method also contemplates the use of other substrates, such as silicon or metal, for example, depending upon the process that is used to release or removed the HDMI interconnect structures therefrom. In the case of these alternative embodiments, the release layer may be a material that may be wet chemical etched after the HDMI structures are formed on the substrate to remove them from the substrate. A metal layer, such a titanium or tungsten, or a silicon dioxide layer may be used as the release layer. In cases where the titanium or tungsten metal layer, or silicon dioxide layer is used as the release layer, an appropriate wet etching procedure is used to totally release the HDMI structures from the carrier. Wet etching procedures are well known to those skilled in the art that will release the HDMI structures.

The present invention achieves or exceeds currently producible fine line density and stability demands for flexible interconnects by using improved materials (polyimide and aluminum or copper) and an improved manufacturing technique for making fine line flexible interconnect structures by fabricating them on the ultraviolet transparent carrier and releasing them by irradiating them individually or in mass using ultraviolet radiation. The present invention allows the formation of all aluminum (radiation hardened) flexible high density multilayer interconnect (HDMI) structures that may be used in space and other military electronic systems.

The present invention allows high density unimetallization (aluminum) to be used to form the fine line met-

allized conductors, which is ideal for power devices. The present invention also provides for a 95% reduction in weight compared to presently available HDMI substrates used in electronics designed for military aircraft and space systems developed by the assignee of the present invention. The present invention has diverse commercial applications where fine pitch interconnects are needed, such as for three-dimensional flexible cables, and membrane IC test boards, and the like, that are to be used at relatively high temperatures, on the order of 165 degrees Celsius.

BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of the present invention may be more readily understood with reference to the following detailed description taken in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

Fig 1 is a cross sectional side view showing fabrication of a flexible high density multilayer interconnect structure formed using methods in accordance with the principles of the present invention; and
Figs. 2a-2c show flow diagrams illustrating details of the present methods.

DETAILED DESCRIPTION

Referring to the drawing figures, Fig 1 is a cross sectional side view showing fabrication of a flexible high density multilayer interconnect (HDMI structure 10 formed using methods 20 in accordance with the principles of the present invention. The flexible HDMI structure 10 is fabricated on a relatively large carrier 11, typically having dimensions on the order of two feet by two feet. In one embodiment of the present invention, the carrier 11 may comprise an ultraviolet transparent substrate or wafer, such as quartz, for example, or a silicon wafer or a metal carrier, for example, depending upon the release technique that is to be used to remove or release the flexible HDMI structures 10 from the carrier 11.

The carrier 11 has a release layer 12 formed or otherwise deposited thereon. When the ultraviolet transparent substrate is used as the carrier 11, a polyimide layer is deposited as the release layer 12. When the silicon substrate is used as the carrier 11, a metal or silicon dioxide layer is deposited as the release layer 12. The metal release layer 12 may be comprised of titanium or tungsten, for example.

The flexible HDMI structure 10 is comprised of a plurality of dielectric layers 15 having fine line metallization patterns 13 formed therethrough that terminate at bond pads 17 on one or more surfaces of the fabricated flexible HDMI structure 10 and at cooperative bond pads (not shown) that are connected to electronic components. For example, each of the HDMI structures 10 may comprise dielectric layers 15 comprising polyimide having aluminum fine line interconnects 13,16 and vias 14 formed therethrough that provide signal paths from the bond pads 17 disposed at the surface of the HDMI structure 10 to other bond pads that are connected to the electronic components. The plurality of HDMI structures 10 are formed on the carrier 11 and release layer 12 using well-known MCM-D processing techniques. Processing that may be used to fabricate the HDMI structures 10 is described in U.S. Patent No. 5,034,091, entitled "Method of Forming an Electrical Via Structure", and assigned to the assignee of the present invention, which is incorporated herein in its entirety by reference.

The release layer 12 is processed to release or remove one or more fabricated HDMI interconnect structures 10 from the carrier 11. More specifically, once the plurality of HDMI structures 10 are formed, in the case where the ultraviolet transparent substrate 11 is used as the carrier 11, a short wavelength ultraviolet radiation source 18, which is programmable and controlled, is used to release individual ones of the HDMI structures 10. A programmable pick and place machine may be used to physically remove the HDMI structures 10 once they are released from the carrier 11.

Alternatively, a flood beam ultraviolet radiation source 18 may be used to release many or all of the HDMI structures 10 from the ultraviolet transparent substrate or carrier 11. The ultraviolet radiation source 18 is caused to radiate ultraviolet radiation through the ultraviolet transparent carrier 11 and onto the release layer 12. For example, an ultraviolet laser may be used to selectively irradiate one of the HDMI structures 10 to release it from the release layer 12.

The ultraviolet radiation (photons) from the ultraviolet radiation source 18 interacts with the polyimide release layer 12 adjacent to the carrier 11 and ruptures or otherwise breaks the adhesive bond therebetween. This permits the HDMI structures 10 to be lifted off of the carrier 11 using the programmable pick and place machine or other tool, for example. Multiple HDMI structures 10 may be released from the carrier 11 using a wide area ultraviolet radiation source 18 in a similar manner.

In cases where the carrier 11 comprises a silicon substrate, a titanium or tungsten metal layer, or a silicon dioxide layer is used as the release layer 12. An appropriate wet etching procedure is used to totally release the HDMI structures 10 from the release layer 12. Wet etching procedures are well known to those skilled in the art that will release the HDMI structures 10.

The present invention achieves or exceeds currently producible fine line density and stability demands for flexible interconnects. The present invention uses improved materials such as polyimide and aluminum to form the HDMI interconnect structures 10 and an improved manufacturing technique for making and releasing the HDMI structures 10 from the carrier 11 either individually or in mass. The present invention allows the formation of all aluminum (radiation hard-

ened) flexible HDMI structures 10 that may be used in space and other military electronic systems.

The present invention allows high density unimetallization (aluminum or copper) to be used to form the fine line metallized interconnects 13,16 and vias 14, which is ideal for power devices. The present invention also provides for a 95% reduction in weight compared to presently available flexible HDMI substrates of the same size that are currently used in electronics designed for military aircraft and space systems developed by the assignee of the present invention. The present invention has diverse commercial applications where fine pitch interconnects are needed, such as for three-dimensional flexible cables, and membrane IC test boards, and the like, that are to be used at relatively high temperatures, on the order of 165 degrees Celsius.

For the purposes of completeness, Figs. 2a-2c show flow diagrams illustrating methods 20 in accordance with the present invention for forming flexible HDMI structures 10 on a carrier 11 and subsequently releasing the HDMI interconnect 35 structures 10 either individually or in total from the carrier 11. The present methods 20 are as follows.

Referring to Fig. 2a, a first method 20a comprises the steps of providing 21a a transparent carrier 11 that is transparent to ultraviolet radiation, forming 22a a release layer 12 on the transparent carrier 11, fabricating 23a flexible high density multilayer interconnect (HDMI) structures 10 on the release layer 12, and processing 24a the release layer 12 to release the flexible HDMI structures 10 from the rigid carrier 11, such as by irradiating the release layer 12 through the transparent carrier 11 using an ultraviolet radiation source 18.

Referring to Fig. 2b, a second method 20b comprises the steps of providing 21a a a carrier 11, such as a silicon carrier, forming 22b a release layer 12, such as a metal (titanium or tungsten) release layer, on the carrier 11, fabricating 23b flexible high density multilayer interconnect (HDMI) structures 10 on the metal release layer 12, and processing 24b the metal release layer 12 to release the flexible HDMI structures 10 from the carrier 11, such as by using a wet etching procedure.

Referring to Fig. 2c, a third method 20c comprises the steps of providing 21c a carrier 11, such as a silicon carrier, forming 22c a release layer 12, such as a silicon dioxide release layer, on the rigid carrier 11, fabricating 23c flexible high density multilayer interconnect (HDMI) structures 10 on the release layer 12, and processing 24c the release layer 12 to release the flexible HDMI structures 10 from the rigid carrier 11, such as by using a wet etching procedure.

Thus, methods for forming flexible HDMI decals comprising flexible fine line interconnect structures have been disclosed. It is to be understood that the described embodiments are merely illustrative of some of the many specific embodiments which represent applications of the principles of the present invention. Clearly, numerous and varied other arrangements may be readily devised by those skilled in the art without departing from the scope of the invention.

Claims

1. A method of fabricating flexible high density multilayer interconnect (HDMI) structures (10), characterized by the steps of:
   - providing (21) a carrier (11);
   - forming (22) a release layer (12) on said carrier (11);
   - fabricating (23) a flexible HDMI structure (10) on said release layer (12) ; and
   - processing (24) said release layer (12) to release and remove said flexible HDMI structure (10) from said carrier (11).
2. The method of claim 1, characterized in that said step (21a) of providing comprises providing a transparent carrier (11).
3. The method of claim 2 characterized in that said carrier (11) is transparent to ultraviolet radiation.
4. The method of any of claims 1 to 3, characterized in that said step (21b; 21c) of providing comprises providing a rigid carrier (11).
5. The method of claim 4, characterized in that said carrier (11) is made of silicon.
6. The method of claims 3 and 4, characterized in that said carrier (11) is made of quartz.
7. The method of any of claims 1 to 6, characterized in that said step (22a) of forming includes forming said release layer (12) from polyimide.
8. The method of any of claims 1 to 6, characterized in that said step (22b;) of forming includes forming said release layer (12) from metal.
9. The method of claim 8, characterized in that said metal is titanium or tungsten.
10. The method of any of claims 1 to 6, characterized in that said step (22c) of forming comprises forming said release layer (12) from silicon dioxide.
11. The method of any of claims 2 to 10, characterized in that said step (24a) of processing said release layer (12) comprises irradiating said release layer (12) through said carrier.
12. The method of any of claims 1 to 10, characterized in that said step (24b) of processing said release

layer (12) comprises wet etching said release layer (12).

13. The method of any of claims 1 to 12, characterized by the further step of providing said HDMI structure (10) with dielectric layers (15) having metal fine line interconnects (13, 16) and vias (14) formed therethrough that provide signal paths from bond pads (17) disposed at the surface of said HDMI structure (10) to associated electronic components.

Fig. 1

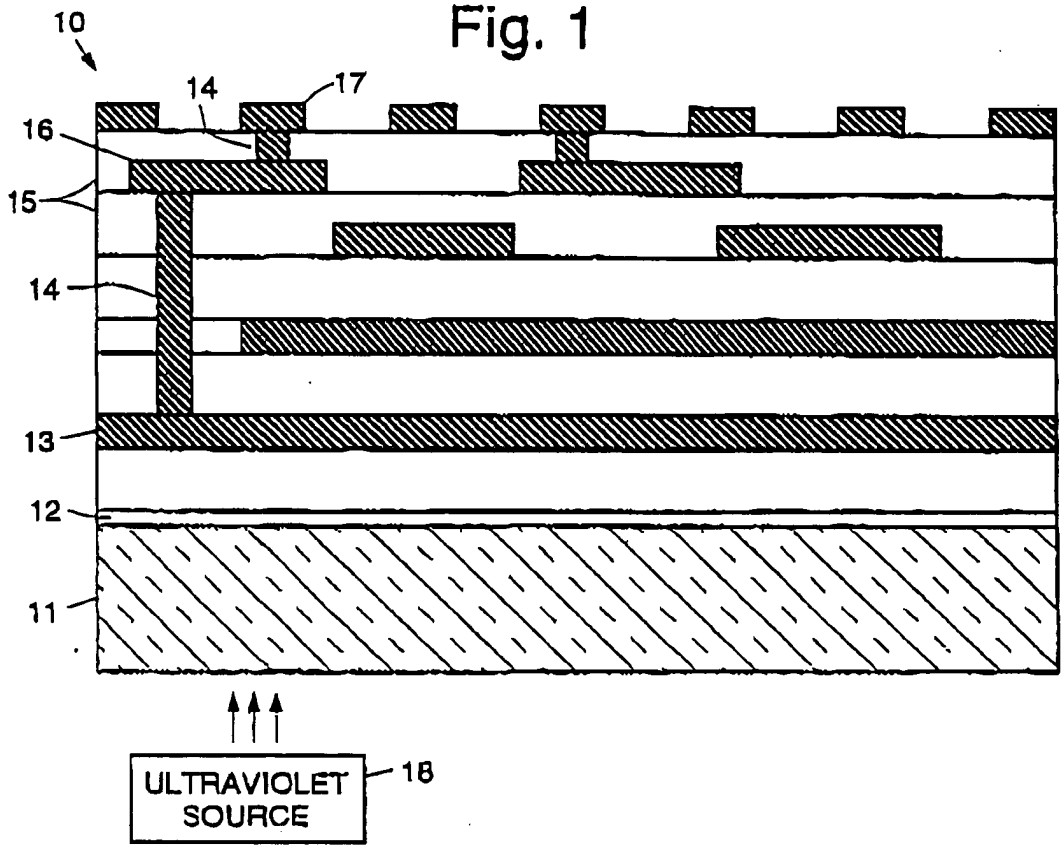

10
14
17
16
15
14
13
12
11
ULTRAVIOLET SOURCE
18

Fig. 2a

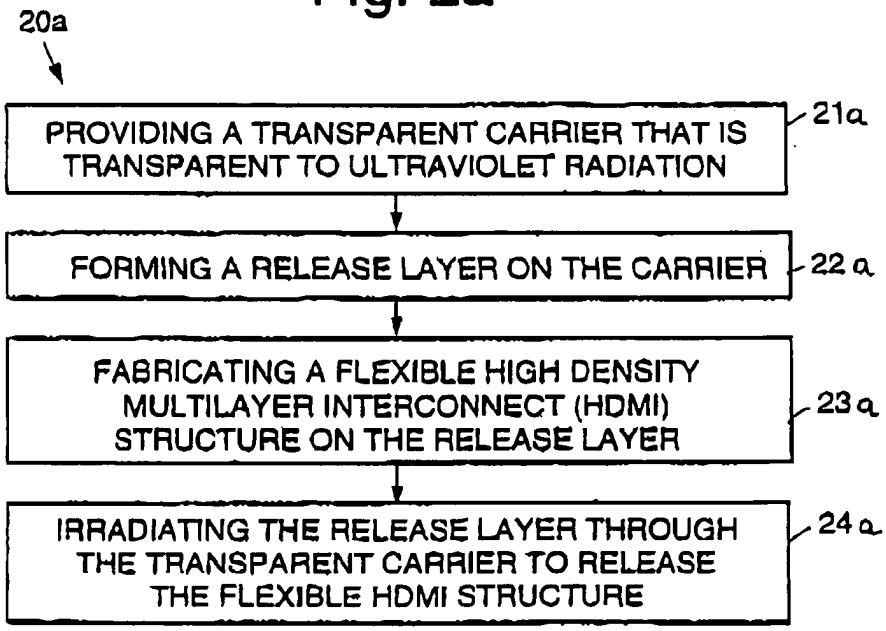

20a
PROVIDING A TRANSPARENT CARRIER THAT IS TRANSPARENT TO ULTRAVIOLET RADIATION
21a
FORMING A RELEASE LAYER ON THE CARRIER
22a
FABRICATING A FLEXIBLE HIGH DENSITY MULTILAYER INTERCONNECT (HDMI) STRUCTURE ON THE RELEASE LAYER
23a
IRRADIATING THE RELEASE LAYER THROUGH THE TRANSPARENT CARRIER TO RELEASE THE FLEXIBLE HDMI STRUCTURE
24a

Fig. 2b

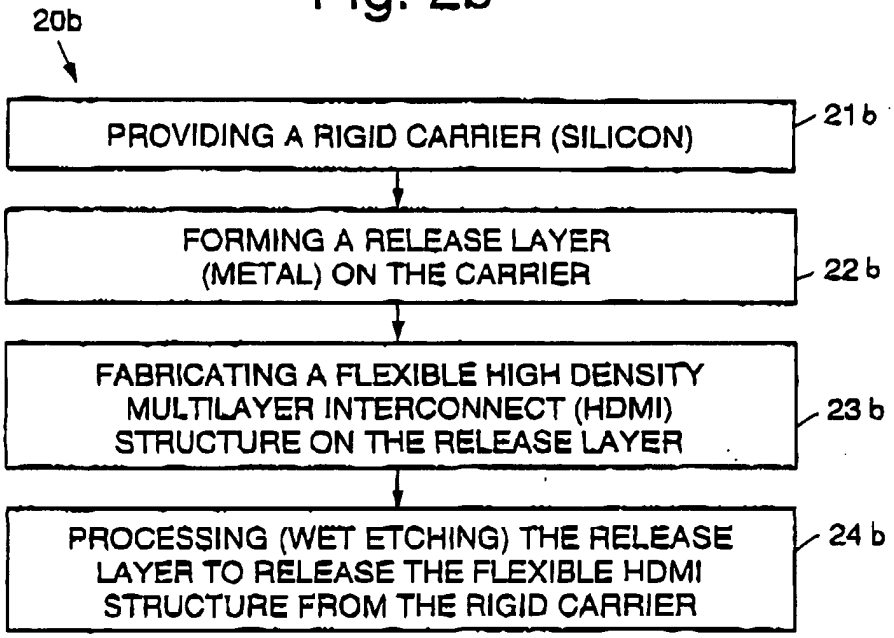
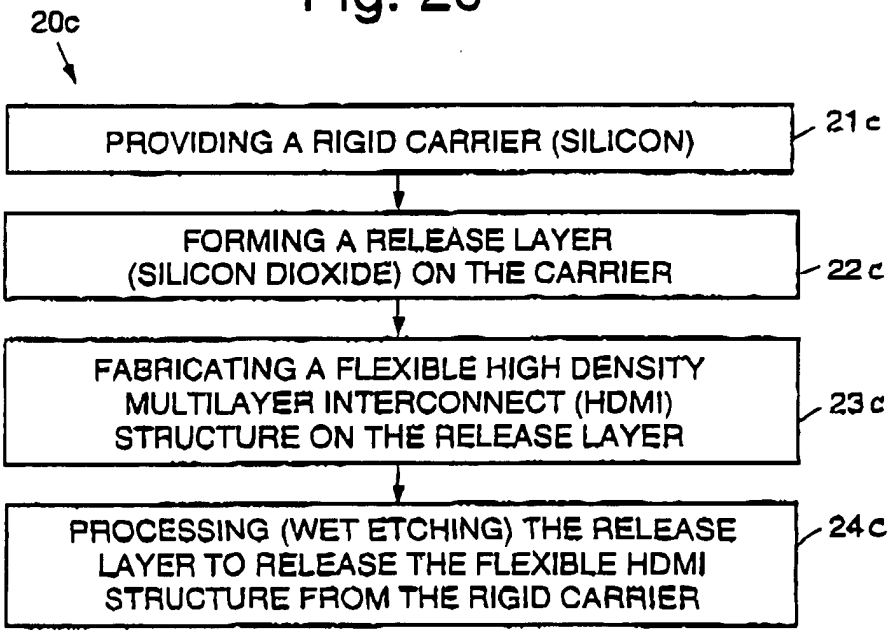

20b
PROVIDING A RIGID CARRIER (SILICON)
21b
FORMING A RELEASE LAYER (METAL) ON THE CARRIER
22b
FABRICATING A FLEXIBLE HIGH DENSITY MULTILAYER INTERCONNECT (HDMI) STRUCTURE ON THE RELEASE LAYER
23b
PROCESSING (WET ETCHING) THE RELEASE LAYER TO RELEASE THE FLEXIBLE HDMI STRUCTURE FROM THE RIGID CARRIER
24b

Fig. 2c


20c
PROVIDING A RIGID CARRIER (SILICON)
21c
FORMING A RELEASE LAYER (SILICON DIOXIDE) ON THE CARRIER
22c
FABRICATING A FLEXIBLE HIGH DENSITY MULTILAYER INTERCONNECT (HDMI) STRUCTURE ON THE RELEASE LAYER
23c
PROCESSING (WET ETCHING) THE RELEASE LAYER TO RELEASE THE FLEXIBLE HDMI STRUCTURE FROM THE RIGID CARRIER
24c